OSD, DEPUTY DIRECTOR OF DEFENSE RESEARCH & ENGINEERING
SMALL BUSINESS INNOVATION RESEARCH PROGRAM

PROGRAM DESCRIPTION

Introduction

The Army, Navy and Air Force hereafter referred to as DoD Components acting on behalf of the Office of Technology Transition in the Office of the Director, Defense Research and Engineering, invite small business firms to submit proposals under this program solicitation entitled Small Business Innovation Research (SBIR). Firms, with strong research and development capabilities in science or engineering in any of the topic areas described in this section and with the ability to commercial the results are encouraged to participate. Subject to availability of funds, DoD Components will support high quality research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector.

Objectives of the DoD SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research and development results.

The DoD Program presented in this solicitation strives to encourage technology transfer with a focus on advanced development projects with a high probability of commercialization success, both in the government and private sector. The guidelines presented in this solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

Three Phase Program

Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR Program and will typically be one half-person year effort over a period not to exceed six months. Proposals should concentrate on that research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other applications. If it appears to have such potential, proposers are encouraged, on an optional basis, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the government funded research and development phases.

Subsequent Phase II awards will be made to firms on the basis of results from the Phase I effort and the scientific, technical and commercial merit of the Phase II proposal. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research and development effort and is expected to produce a well defined deliverable product or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, the small business is expected to use non-federal capital to pursue private sector applications of the research development. Also, under Phase III, federal agencies may award non-SBIR funded follow-on contracts for products or processes which meet the mission needs of those agencies. This solicitation is designed, in part, to encourage the conversion of federally sponsored research and development innovation into private sector applications. The federal research and development can serve as both a technical and pre-venture capital base for ideas which may have commercial potential.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will not be considered under this solicitation; however, offerors who were not a awarded contract in response to a

particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in this section.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts, and have successfully completed their Phase I efforts, will be considered. DoD is not obligated to make any awards under either Phase I, II, or III. DoD is not responsible for any money expended by the proposer before award of any contract.

The Fast Track provisions in section 4.0 of this solicitation apply.

Follow-On Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is conversion of DoD-supported research and development into commercial products. Proposers are encouraged to obtain a contingent commitment for private follow-on funding prior to Phase 11 where it is felt that the research and development has commercial potential in the private sector. Proposers who feel that their research and development have the potential to meet private sector market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue private sector development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent upon the DoD supported development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase Ill. Note that when several Phase II proposals receive evaluations being of approximately equal merit, proposals that demonstrate such a commitment for follow-on funding will receive extra consideration during the evaluation process. The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies stated elsewhere in this solicitation.

Contact with DoD

General Information questions pertaining to proposal instructions contained in this solicitation should be directed to:

DOD SBIR/STTR Help Desk
Phone: (800)382-4634 (8am to 8pm E.S.T)
Fax: (800)462-4128
email: SBIRHELP@us.teltech.com

Other questions pertaining to a specific DoD Component should be directed to the point of contact identified in the topic description section of this solicitation. Proposals should be mailed to the address identified for this purpose in the topic description section. Oral communications with DoD Components regarding the technical content of this solicitation during the Phase I proposal preparation periods are prohibited for reasons of competitive fairness.

OSD DEPUTY DIRECTOR OF DEFENSE RESEARCH & ENGINEERING
FY 1997 Topic Descriptions

ARMY, Simulation Training and Instrumentation Command (STRICOM)

Technology Focus Area: The Commercialization of High Level Architecture (HLA) and Data Representation

DoD has mandated that all its simulations will be compliant with the High Level Architecture by the year 2001. HLA represents an architecture for future simulations. It is based on the concept of a federation in which a set of simulations work together in a structural way to support diverse-user needs. The HLA has been designed to support interoperability and reuse of DoD simulations, however as a technical architecture it provides multiple opportunities for both development of commercial products to support HLA federations and for use of HLA to support simulation applications beyond the DoD. Extensive information is available on the world wide web at {//www.dmso.mil/projects/hla/} and from the Proceedings of the 15th Workshop on the Interoperability of Distributed Interactive Simulations (IST-CF-96-01.1) September 16-20 1996. A Technical Information Package (TIP) with details on the following topics is available for the Defense Technical Information Center.

The following topics support the commercialization of HLA and are structured to provide both DoD and the Commercial Simulation Consumer with enhanced products. The offerors should discuss, in software development terminology, the simulation application's object oriented structure, to include the use of object model template, run time infrastructure, and data representation with the proposed simulation applications. These simulation applications should be discussed as federate in either an existing "known implementation - from the workshop" or a new implementation of a federation.

DEFINITIONS: The following HLA definitions apply to all of the following HLA topics:

Federate - A member of a HLA Federation. All applications participating in a Federation are called Federates. In reality, this may include Federate Managers, data collectors, live entity surrogates simulations, or passive viewers.

Federation - A named set of interacting federates, a common federation object model, and supporting RTI, that are used as a whole to achieve some specific objective.

Federation Object Model (FOM) - An identification of the essential classes of objects, object attributes, and object interactions that are used as a whole to achieve a more complete description of the federation structure and/or behavior.

Runtime Infrastructure (RTI) - The general purpose distributed operating system software which provides the common interface services during the runtime of an HLA federation.

Synthetic Environment Data Representation and Interchange Specification (SEDRIS) - A format-independent data representation model for interchanging synthetic environment databases, including any combination of (but not limited to): terrain, ocean, atmosphere, 3D icons/models, features, topology, sound, textures, symbols, and special effects.

PRIMARY POINT OF CONTACT: (STRICOM)

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OSD97-001 Title: HLA Federation Implementation Tools

TECHNOLOGY: Modeling and Simulation

OBJECTIVE: To develop new and innovative technological solutions to support the development and implementation of High Level Architecture (HLA) federation. These tools target the planning or design phase prior to any Federation operation/interactions.

DESCRIPTION: The need exists to design and develop infrastructure tools to aid in the implementation and use of the HLA to develop, implement and use HLA federations. These tools are desired to provide developers of simulation systems an implementation method for functionality, high fidelity, interoperability, and compliance at a low cost. These tools should address the establishment of the federation object model and the determination of the ~~a~~ level of interoperation for a group of simulation applications to operate in a federation. DoD has established the process in the HLA Federation Development and Execution Process Model which lays out a general view of this process. However, objective is the development of a commercial applications, an open tool architecture is planned, with published data interchange to allow open use of DoD data resources and equivalent commercial information the use of information from a Modeling and Simulation Resource Repository is optional. The offeror should establish the commercial equivalent of these data requirements or identify that they are not required for commercial applications. These tools help to establish a baseline for federation development and integration.

PHASE I: Explore concepts, methodologies, and design possibilities for tools to support the development of a federation baseline for either a commercial or DoD application.

PHASE II: Develop and demonstrate the approach from Phase I. The product could be used by multiple simulation application manufactures to establish and develop common interactions and information transfer in an HLA federation to accomplish a specific objective (in manufacturing, analysis, simulation or design).

DUAL USE COMMERCIALIZATION: DoD believes that HLA is the technology thrust for interoperability. Commercial applications which desire to interoperate could use the same paradigm. The process of facilitating a federate and federation is labor intensive. The use of sophisticated tool sets which alleviate tasks and enable more efficient implementations for commercial developers are desired. Candidates for dual use include information systems management, manufacturing control, and distributed games.

REFERENCES: Hunt, Dahman, Lutz, and Sheehan "Planning for the Evolution of Automated Tools in HLA"
The world wide web at {//www.dmso.mil/projects/hla/ } and from the Proceedings of the 15th Workshop on the Interoperability of Distributed Interactive Simulations (IST-CF-96-01.1) September 16-20 1996.
A Technical Information Package (TIP) is available for the Defense Technical Information Center.

OSD97-002 TITLE: HLA Runtime Analysis and Monitoring Tools

TECHNOLOGY: Modeling and Simulation

OBJECTIVE: Provide realistic real-time monitoring for the federation, or any federate, during the federation's operation. These tools support activities during federate operation and can provide feedback in after action review.

DESCRIPTION: This type of analysis and monitoring tool ensures proper/legitimate operation of a federation interacting over a network. This includes but, is not limited to, (two Dimensional Plan View Display, a Stealth viewer including attachment to an operating simulation) a recorder and playback capability, a federation controller, ~~and~~ a network performance monitor and data visualization techniques eg.,. Portions of the stored data may be at different physical sites, therefore, effects of distributed recording must be addressed and supported. There have been solutions to the visualization of the simulated battlefield which partially answer the questions of the operation and health of a distributed network implementation. However, a low cost modular approach is needed for use with DoD's HLA and its commercial equivalent. The offeror should review the current capabilities and evolve a flexible HLA compliant implementation which uses the federation object model, and initialization data of a protofederation or a potential commercial application.

PHASE I: Based on real time simulation requirements, design analysis and oversight tools which provide a low cost modular solution for the real time analysis and oversight of an HLA distributed federation.

PHASE II: Based on either a DoD demonstration or a commercial federation implementation, prototype the analysis and oversight tools.

DUAL USE COMMERCIALIZATION: Candidates for dual use include information systems management, manufacturing control, and distributed games.

REFERENCES: Hunt, Dahman, Lutz, and Sheehan "Planning for the Evolution of Automated Tools in HLA"
The world wide web at {//www.dmso.mil/projects/hla/ } and from the Proceedings of the 15th Workshop on the Interoperability of Distributed Interactive Simulations (IST-CF-96-01.1) September 16-20 1996.
A Technical Information Package (TIP) is available for the Defense Technical Information Center.

OSD97-003 TITLE: HLA Commercial Applications in Simulation

TECHNOLOGY: Modeling and Simulation

OBJECTIVE: Demonstrate that HLA provides a commercially viable real-time simulation approach. (An HLA instantiation)

DESCRIPTION: Based on the constructs of HLA, establish a federation object model for a specific objective, design and integrate a commercial group of federates to perform this specific commercial implementation. The offeror should discuss the federation object model, environmental representation, and either the use of a special purpose run time infrastructure (RTI) or request the Government's RTI. The offeror can propose to use the DoD prototype developments, or can suggest alternative solutions. The use of either a commercial variant or a commercial application will help verify the validity of the HLA, and provide opportunities for novel design. This commercial application of a federation could be a real-time interactive game, a real-time management and oversight of a manufacturing facility or another commercial application.

PHASE I: Based on real-time simulation requirements, design a commercial federation (A named set of interacting common object models, and supporting RTI, that are used as a whole to achieve some specific objective).

PHASE II: Prototype and demonstrate the federation.

DUAL USE COMMERCIALIZATION: Candidates for dual use include information systems management, manufacturing control, and distributed games in a virtual environment.

REFERENCES: The world wide web at {//www.dmso.mil/projects/hla/} and The Proceedings of the 15th Workshop on the Interoperability of Distributed Interactive Simulations (IST-CF-96-01.1) September 16-20 1996.
A Technical Information Package (TIP) is available for the Defense Technical Information Center.

OSD97-004 TITLE: Visual Representation within the HLA

TECHNOLOGY: High Performance Computing and Simulation

OBJECTIVE: Demonstrate realistic dynamic images for a distributed virtual gaming environment operating in an HLA environment.

DESCRIPTION: Using the HLA and Run Time Infrastructure (RTI) constructs and the Synthetic Environment Data Representation Interface Specification (SEDRIS) demonstrate commercial applications for high resolution displays.

PHASE I: Based on real-time simulation requirements design a visual presentation either in a helmet mounted display or on a graphics workstation. Extract a synthetic environment for a small gaming area from an existing SEDRIS data base. Design a small set of typical interactions required between two ground players and two

aircraft and implement the interactions using the RTI. Perform an analysis to determine the capability of the HLA infrastructure and the resulting synthetic environment to support a distributed virtual gaming environment.

PHASE II: Prototype the simulation and meet real time frame rates using the synthetic environment developed from SEDRIS, air and ground players. Demonstrate the capability of the synthetic environment representation and the RTI to support dynamic changes to the environment.

DUAL USE COMMERCIALIZATION: Candidates for dual use include information systems management, manufacturing control, and distributed games in a virtual environment.

REFERENCES: The world wide web at {//www.dmso.mil/projects/hla/ } and The Proceedings of the 15th Workshop on the Interoperability of Distributed Interactive Simulations (IST-CF-96-01.1) September 16-20 1996. A Technical Information Package (TIP) is available for the Defense Technical Information Center.

OSD97-005 TITLE: Stimuli (non-visual) Representation within the HLA

TECHNOLOGY: Modeling and Simulation

OBJECTIVE: Demonstrate that HLA supports the implementation of different sensory stimuli (other than visual) in the virtual environment. This topic addresses the potential of haptic, audio, olfactory and other stimuli into the virtual reality within the HLA paradigm.

DESCRIPTION: Provide a novel approach which supports sensory stimulation using the HLA constructs and its environmental data. This topic provides the avenue to ensure that alternate sensory data and its representation can be supported within a federated object model, the RTI and its environmental representation.

PHASE I: Identify at least one stimuli, model the stimuli in a federated object model and design an implementation which supports a real time presentation of the stimuli. The Offerors should describe the interaction which support the sensory stimulation in a virtual environment. Describe the external federate activity which causes the need for the activation of a stimuli, and the timing and effect of that stimuli on the participant.

PHASE II: Build and demonstrate a prototype of the sensory stimulation system.

DUAL USE COMMERCIALIZATION: Candidates for dual use include information systems management, manufacturing control, and distributed games in a virtual environment.

REFERENCES: The world wide web at {//www.dmso.mil/projects/hla/ } and The Proceedings of the 15th Workshop on the Interoperability of Distributed Interactive Simulations (IST-CF-96-01.1) September 16-20 1996. A Technical Information Package (TIP) is available for the Defense Technical Information Center.

OSD97-006 TITLE: Commercialization of Components C4I Interface to Simulation using HLA

TECHNOLOGY: Modeling and Simulation

OBJECTIVE: Many simulations require tactical intelligence information and audio communication. This topic's thrust is to develop commercial applications which use the current C4I HLA constructs.(HLA instantiation)

DESCRIPTION: The need exists to accommodate a wide variety of real-world command, control, communications, computers, and intelligence (C4I) equipment into the synthetic environment. A primary DoD thrust for this effort is the Modular Reconfigurable C4I Interface (MRCI).

PHASE I: Establish a set of C4I simulations and interfaces which have commercial value. Based on this set of applications, establish a scaleable design for this simulation application.

PHASE II: Prototype the design and demonstrate it in either a DoD or commercial Federation.

DUAL USE COMMERCIALIZATION: The ability to inject audio communications and intelligence is applicable to the information technology management, telemedicine applications and distributed game market, which use integrate analogue and digital signals.

REFERENCES: Position Paper 96-15-056 “Detailed Design of the Modular Reconfigurable C4I Interface (MRCI)” by Tom Tiernan, NRaD and Mark Cosby, SAIC
The world wide web at {//www.dmso.mil/projects/hla/ } and The Proceedings of the 15th Workshop on the Interoperability of Distributed Interactive Simulations (IST-CF-96-01.1) September 16-20 1996.
A Technical Information Package (TIP) is available for the Defense Technical Information Center.

OSD97-007 TITLE: Data Management/ Analysis Tools

TECHNOLOGY: Modeling and Simulation

OBJECTIVE: Rapid reduction and analysis of federate and federation data is required. This analysis spans from an attribute level comparison through the sophisticated analysis on a simulation effect. The ability to parse data including audio and video data in a near real time analysis capability is required.

DESCRIPTION: There are large volumes of data used in federate and federation initialization and operation. The federation performance cannot be efficiently reviewed without automated data management tools. Analyze the effect of an additional passive federate on an exercise. These tools will allow the reconstruction of an entire federation exercise. This topic requires the synthesis of distributed recorded data, and the decomposition of the data into significant activities for replay and analysis. PHASE I: Design a modular data management process which will support all federation generated data. Identify approaches to increase response times.

PHASE II: Prototype data management system for use on a DoD or commercial federation.

DUAL USE COMMERCIALIZATION: There is a large community who desire rapid access and analysis of data. Techniques should support commercial information technology data management.

REFERENCES: The world wide web at {//www.dmso.mil/projects/hla/ } and The Proceedings of the 15th Workshop on the Interoperability of Distributed Interactive Simulations (IST-CF-96-01.1) September 16-20 1996.

NAVY, Naval Undersea Warfare Center Division, Newport

Technology Focus Area: Sensors

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SBIR OSD97-### Atten: Code 5912
NUWC Division, Newport
Simon Pietri Drive
Newport, RI 02841-1708

OSD97-008 TITLE: Underwater Acoustic/Optical Imaging

OBJECTIVE: Develop an underwater acoustic/optical imaging system or innovative sensors

DESCRIPTION: Combining the complementary strengths of acoustic and optical imaging technologies offers the potential to enhance the quality of underwater images required in a variety of military and civilian applications. Such combinations have been demonstrated with, for instance, ultrasonic sonar and laser line scan. This topic requests the development of innovative acoustic/optical technologies to be combined in an affordable imaging system suitable, depending on design, to such applications as hand held devices for divers, systems for unmanned underwater vehicles or stations, larger subsurface or surface craft. Proposals must demonstrate the intention to develop a dual use product and an understanding of what such development entails. The objective of the topic is the development of an innovative imaging system based on innovative acoustic/optical sensors.

PHASE I: Design, develop, fabricate, and demonstrate proof of concept sensors.

PHASE II: Fabricate and evaluate a prototype of the imaging system which combines sensors, developed in Phase I.

DUAL USE COMMERCIALIZATION: The system will have similar civilian and military applications such identifying underwater objects, finding environmental hazards, imaging for underwater construction or structural inspection, conducting research.

OSD97-009 TITLE: High Efficiency, Broadband, Acoustic Transducers/Arrays for Various Underwater Applications

OBJECTIVE: Develop reliable, simple affordable, highly efficient, broadband acoustic transducers/arrays for a variety of underwater applications.

DESCRIPTION: Recent developments in materials suitable for transduction and the design of multi-layer active drivers provide the potential for transducers which can satisfy military and nonmilitary applications with more versatility and more simply, reliably, and affordably than previously possible. Such materials include piezoelectric and electrostrictive ceramics, magnetostrictive alloys, electroactive polymers, and electrostrictive urethanes. This topic contains two subtopics. Offerors may propose under either or both subtopics; however, separate proposals shall be provided for each subtopic. The emphasis is development of transduction mechanisms vice new material development.

Subtopic 1. Multi-purpose Conformal arrays. Under this subtopic, offerors should propose arrays which serve more than one function and which, if used at deep depths, are operable without a pressure compensation

system. Applications (depending on frequency): close in imaging, for instance in the near surf; generation of high intensity ultrasound to effect sonochemical reactions or generate cavitation to break up and neutralize oil globules or hazardous biological waste; underwater acoustic communications; passive detection and localization of other platforms or marine mammals; acoustic communications; reduction of radiated vehicle noise and/or vibration for military or nonmilitary vehicles and vessels to increase detection ability and to provide greater passenger comfort. In the high frequency (above 20 kHz) regime, very broadband highly efficient arrays capable of handling very high power densities and suitable for versatile use in shallow water; lightweight, less powerful imaging arrays suitable for diver use. In the lower frequency regime (below 4 kHz): reversible underwater arrays for radially compact conformal mounting on the outer surface of a submersible hull, such as a Unmanned Underwater Vehicle (UUV); capable of wide bandwidth transmit, receive, and beamforming and of functioning as an actively controllable surface for radiated noise reduction below 2 kHz.

Subtopic 2. Low frequency projector for deep depths. Applications: acoustic tomography studies; oceanographic experiments; undersea warfare. Underwater acoustic projector capable of acoustic power output of 500 watts from 50 Hz through 100 Hz with an electroacoustic efficiency greater than 50%. Operable at depths up to 1000 meters without an active compensation system. Must be environmentally suitable to be used as an expendable source.

PHASE I: Design and document design rationale. Fabricate and demonstrate proof of concept element(s).

PHASE II: Modify design as required. Fabricate and demonstrate prototype device.

DUAL-USE COMMERCIALIZATION: See subtopics above. Proposals should demonstrate that offerors have carefully considered the challenges offered by developing technology into dual-use products.

OSD97-010 TITLE: Affordable Underwater Sensing Technology for Autonomous Underwater Vehicles (AUVs)

OBJECTIVE: Develop affordable sensing technology on a scale suitable for integration on AUVs.

DESCRIPTION: Physical, fluorescence and other optical sensing technologies can now be configured for integration onto AUVs for shallow and very shallow water applications. Several sensor technologies are on the threshold of achieving the affordability, low-power, robustness, and miniaturization needed for such applications. For Navy applications, the sensors would be housed on a 7" internal diameter autonomous swimming vehicle or on a 9" x 13.5" x 5" bottom crawler. for undersea warfare and dual use applications.

PHASE I: Develop a preliminary design utilizing affordable physical and optical sensing, vehicle configuration and component integration. Develop proof of concept sensors and conduct preliminary field testing.

PHASE II: Develop final version of the design. Fabricate prototype sensor system, integrate on AUV, and test in both a military and industrial sector application.

DUAL-USE COMMERCIALIZATION: Applications of this technology include: Tactical Oceanography for shallow and very shallow water operations; small object search and detection; environmental monitoring; mapping of sewage plumes, oil spills, hazardous waste and nuclear disaster sites; humanitarian de-mining; waste dump management.

REFERENCES:

[1] "Sensors for Oceanographic Applications of Autonomous Underwater Vehicles", J. W. Bales MIT Sea Grant College Program, E.R. Levine NUWCDIVNPT, 21st Annual Technical Symposium and Exhibition,AUVS-94, May 23-25, 1994, pp 439-446.

[2] "Dual-Use Applications Using a Flotilla of Smart Mobile Sensors", C.N. Duarte NUWCDIVNPT, D.T. Gomez, NUWCDIVNPT, SYMPOSIUM ON AUTONOMOUS VEHICLES IN MINE COUNTER MEASURES, April 4-7, 1995, pp 9-64 - 9-73.

OSD97-011 TITLE: Small, Low Power, Low Cost Beamformer for Portable Imaging Sonar

TECHNOLOGY: High Resolution Beamformer Technology, Sonar Signal Processing Technology.

OBJECTIVE: Develop small, low power, low cost beamformer suitable for use in small high frequency imaging sonars.

DESCRIPTION: Advances in chip technology provide the potential for high resolution two-dimensional beamforming in a package suitable for use, for example, in a diver's hand held imaging array, in a remote imaging sonar on an unmanned undersea vehicle, or with a small surface craft sonar for obstacle avoidance. An innovative approach in beamformer technology is required to meet the size, power and cost objectives. Innovation is also required in system design to reduce high data rates generated at the array to a level compatible with a high performance signal processing which would form the images. The two-dimensional beamformer could be tested on a Government owned high resolution planar sonar array at a Government test facility. Such an array would have on the order of 100 transducer elements and thus allowing an equal number of beams to be formed. The elements would spaced at one-half wavelengths for the center frequency. The center frequency of an array of small enough size can range from 50 kHz to 500 kHz.

PHASE I: Conduct design and analysis for a two-dimensional beamformer and multiplexer suitable for a portable imaging sonar handling approximately 100 channels of transducer data.

PHASE II: Design, optimization, fabrication and test of full system data multiplexer and two-dimensional beamformer. Full 100 channel (approximate channel size) system data multiplexer and two-dimensional beamformer demonstration.

DUAL-USE COMMERCIALIZATION: Current or potential applications include use with sonar arrays for: hand held imaging systems; remotely piloted or autonomous undersea vehicles in support of cable-laying, pipe-following, and salvage; surface or underwater obstacle avoidance; oceanographic research.

REFERENCE: F. Nussbaum, G. Stevens, and J. Kelly, "Sensors for a Forward-Looking High Resolution AUV Sonar," Proceedings of the 1996 IEEE Symposium on Autonomous Underwater Vehicle Technology, 1996, p.141

OSD97-012 TITLE: Piezoelectric Ceramics for High Performance Acoustic Transducers

OBJECTIVE: Develop innovative piezoelectric ceramic formulations or materials processing methods that lead to enhanced performance acoustic transducers.

DESCRIPTION: At the heart of an acoustic transducer lies a material that performs the essential role of electromechanical energy conversion, converting and electrical signal into an interrogating acoustic pulse on transmission, and converting the weak acoustic echoes into an electrical signal on reception. Innovations are sought in the composition of, or processing methods used to make, piezoelectric ceramics for this essential transduction task. The focus of the work lies on the materials processing, but the goal is property improvements that lead to enhanced acoustic transducers for applications ranging from Navy sonar systems to civilian underwater imaging for the detection and clearance of environmental hazards in coastal waters.

PHASE I: Establish feasibility of the proposed composition or processing methods to produce piezoelectric ceramics with properties which will lead to enhanced acoustic transducer performance.

PHASE II: Develop the synthesis or processing regimen to prototype production and demonstrate improved transducer performance in candidate devices.

PHASE III: Manufacture piezoelectric materials with enhanced performance characteristics and supply them to transducer and systems manufacturers.

DUAL USE COMMERCIALIZATION: In addition to their vital role in most Navy sonar transducers, piezoelectric ceramics play a critical role in a wide range of civilian acoustic transducer applications: ultrasonic transducers for medical diagnostic imaging, vibration sensors and actuators in active noise suppression system for air conditioners and the like, and underwater imaging devices for detecting and clearing environmental hazards from coastal waters.

REFERENCES: Proceedings of the 1996 IEEE International Symposium on the Applications of Ferroelectrics
Proceedings of the 1996 IEEE International Ultrasonics Symposium.

OSD97-013 TITLE: Automated Sound Velocity Profiler

OBJECTIVE: Develop innovative, affordable, automated system, including launch and handling, for sampling the sound velocity profile in the water column.

DESCRIPTION: Hand launched expendable devices, such as expendable bathythermographs (XBTs) or sound velocimeters (XSVs) are currently used to sample water column properties. Recent work at the Naval Undersea Warfare Center Division, Newport (NUWCDIVNPT) has focused on possible alternative devices for obtaining the sound velocity profile (SVP). This topic seeks to explore alternative approaches. The SVP is used as input for sonar performance prediction calculations. Launching expendable devices adds to work assignments. In addition, the environmental variability of littoral waters increases the necessity for sampling more frequently and, therefore, increases workload. Developing the technology for an automated or partially automated method for sampling the sound velocity profile without expendable devices would provide increased reliability and maintainability and decrease workload.

PHASE I: Explore alternative technologies for environmental sampling and conduct a tradeoff study to determine the most promising approach. Conduct a design concept study to determine the feasibility of implementing the selected approach. For the Navy, the design concept study must present options which define ship impacts and the integration of device output with a combat system necessary to achieve goals of reduced workload. Provide a detailed design document of the device which implements the recommended technology. Conduct breadboard
tests to demonstrate feasibility of approach.

PHASE II: Fabricate a prototype system and conduct performance verification tests.

DUAL-USE COMMERCIALIZATION: This technology is applicable to the next generation Navy surface combatant and as retrofits to current surface combatants, especially in light of the Navy's goal of reduced manning. The technology can benefit commercial activities that require environmental data acquisition such as oil exploration, environmental monitoring, and power plant discharge monitoring.

REFERENCES:
[1] Acoustic - Optic Sound Velocity Profiler, US Patent 5,379,270
[2] Fiber Optic Measurement of the Sound Velocity Profile (Naval Undersea Warfare Center Division, Newport patent in preparation)
[3] Robert J. Urick, Principles of Underwater Sound. New York: McGraw-Hill, 1975, pp. 104-113.

AIR FORCE, Wright Laboratory Topics

Technology Focus Area: Materials and Materials Manufacturing Technology

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OSD97-014 TITLE: Applications of High Temperature Organic Matrix Composites

TECHNOLOGY: Investigate potential high temperature organic resins that can produced organic matrix composite components by resin transfer molding (RTM) at an operating environment of 700°F.

DESCRIPTION: RTM is rapidly maturing as a processing method of choice to produce affordable, high quality composite components for a number of applications. Currently, the RTM resins with the highest temperature capability are bismaleimides. However, new applications require an RTM resin capable of service at higher temperatures than current resins allow. Examples of possible resin which approach an operating environment of 700°F, and also have properties amenable to RTM processing include, but are not limited to, polyimides, and phthalonitriles.

PHASE I: Explore available high temperature resins to determine properties needed for RTM processing. If necessary, modify the resin formulations or develop new resin formulations. Demonstrate high temperature operating properties at 700°F and the ability to RTM the resin.

PHASE II: Scale up the resin to quantities needed to fabricate large, complex parts for military or commercial applications using RTM. Also, demonstrate the ability to make these types of parts using RTM.

DUAL-USE COMMERCIALIZATITON: High temperature composite materials produced by RTM are excellent candidates for turbine engine components for military and commercial aircraft. These materials may also find application as brake parts, and there are numerous potential applications for high quality, high temperature composites throughout the DoD and commercial sectors.

REFERENCES: 1. S.B. Sastri, J.P. Armistead, and T.M. Keller, Proc. 41st Int. SAMPLE Symp., 171-177 (1996)

OSD97-015 TITLE: Solvent-Free, High T_g Polymer Processing Techniques For Aircraft Canopies

TECHNOLOGY: Materials, Processes and Structures

OBJECTIVE: Investigate, design and develop viable processing techniques which retain or improve optical transparency and impact properties for high glass transition polymers.

DESCRIPTION: New high use temperature polymeric materials shall be required for use in future airframes to enable the full performance characteristics of the weapon systems. Some new high temperature transparent thermoplastics have been prepared in recent years which possess glass transition temperatures (T_g's) up to 250-350 degrees C and minimum room temperature tensile mechanical values of 0.45 Msi modulus, 11 Ksi strength and 4.7% elongation to break. New manufacturing technology in non-solvent based processing techniques which retain or improve the inherent optical and mechanical properties at room temperature as well as maintain reasonable processing temperatures is sought. Typical melt consolidation above T_g and pressures of up to 100 Ksi may make for unrealistic fabrication for large commercial scale sheets compared to the state-of-the-art injection molding and

extrusion devices. A model forming technique and device design is sought for proof of concept using such high T_g materials.

PHASE I: Phase I effort shall include the familiarization of the offeror with high use temperature (i.e., >400°F, long term) thermoplastics in order to identify families of potential candidate transparent aircraft transparency materials. Synthesis of the novel candidate materials to large scale (i.e., tens of pounds) shall be required. The Phase I research shall also enable the offeror to evaluate the existing and improved forming techniques, to design a prototype fabrication device to produce a transparent high T_g disk-shaped specimen nominally 1" dia. X 1/8" thick, to fabricate 5-10 specimens of a designated high use temperature candidate material with the described dimensions, and evaluate thermomechanical (including impact) properties, optical parameters such as luminous transmittance, haze and yellowness index at room temperature and near T_g and accelerated aging techniques such as QUV and rain erosion.

PHASE II : In Phase II of the effort the technical work shall require the acquisition and fabrication of larger and more complex shaped specimens of high use temperature transparent materials based on the technology developed in Phase I. Evaluation of the optical quality of the materials shall continue with examination of formulated resins and the effects of the processing technique or modifications thereof upon QUV, weathering (durability), luminous transmittance, haze and yellowness index. Full thermoanalytical, thermomechanical and rheological characterization shall also be required as modifications to the forming process are completed.

DUAL USE COMMERCIALIZATION POTENTIAL: Dual use potential exists for the successful process that optimizes low operating cost and rapid cycle with high use temperature amorphous or semi-crystalline thermoplastics. Commercial applications would include high impact resistant, high use temperature personal protective goggles and face shields, and lenses for elevated temperature environments, and flame resistant commercial aircraft windows.

REFERENCES: (1) DTIC AD-A267-526 (1993) and DTIC A229-339 (1990). (2) L.K. English, *Materials Engineering* 68 (May 1988). (3) S. Witzler, *Advanced Composites* 55 (March/April 1988). (4) P. M. Hergenrother et al., *Polymer 29 (2)* 358 (1988).

OSD97-016 TITLE: Materials for Rocket Propulsion

OBJECTIVE: Develop advanced rocket propulsion materials and cost effective techniques for their fabrication.

DESCRIPTION: There is a critical need for novel, innovative approaches in the development and processing of materials which can aid the advancement of rocket propulsion technologies. For example, the year 2010 goals of the DoD/NASA Integrated High Payoff Rocket Propulsion Technology (IHPRPT) Initiative cannot be met without new materials and manufacturing processes that increase performance, reduce weight, and decrease hardware and support costs of rocket propulsion systems. Specifically, goals for booster systems include: 1) increasing liquid rocket engine thrust-to-weight by 100%; 2) increasing mass fraction of solid motors by 35%; and 3) decreasing cost and time of manufacturing by 25%. New approaches are requested to develop and characterize:
(a) advanced materials that can meet these goals; and/or (b) innovative, cost effective processing techniques for these materials. Candidate materials include, but are not limited to, polymers, polymer matrix composites, metals and intermetallics, metal matrix composites, ceramics, ceramic matrix composites, carbon-carbon composites, thermal barrier coatings, and functionally graded materials. Research in this Topic is anticipated to provide a maximum of innovative flexibility while yielding promising commercial application/dual use technologies to prospective investigators.

PHASE I: This program will focus on the critical propulsion material and processing issues which, when successfully addressed, will provide proof of concept. Proposals should demonstrate reasonable expectation that proof of principle can be attained within Phase I, and that results will favorably impact future component application of these materials.

PHASE II: This program will be structured to develop and refine those feasible concepts to the point where performance is demonstrated on a scale sufficient to permit an assessment of the ultimate application potential to help meet Air Force advanced rocket propulsion needs.

POTENTIAL COMMERCIAL MARKET: Materials for rocket propulsion will transition into the US commercial space launch industry, thus enabling the US industry to more favorably compete with foreign sources for space launch opportunities through reducing the life cycle cost of inserting payloads to space obit. Materials for rocket propulsion technologies also serve the commercial sector by enhancing our ability in remanufacture and maintenance of the US ballistic missile fleet.

REFERENCES:
1. "Materials for Advanced Rocket Propulsion--An Assessment of Materials and Process Development Needs," E.L. Courtright, et.al., Wright Laboratory Technical Report WL-TR-96-4086, Wright-Patterson AFB, OH, December 1996.
2. "The Integrated High Payoff Rocket Propulsion Technology (IHPRPT) Program," M. Wierschke, 1995 JANNAF Propulsion Meeting Proceedings, JHU Chemical Propulsion Information Agency, Columbia, MD, 1995.

Technology Focus Area: Materials Manufacturing Technology

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OSD97-017 TITLE: Breathable Release Coating Development to Use on Ceramic Tooling

DOD CRITICAL TECHNOLOGY AREA: Manufacturing Science & Technology

OBJECTIVE: Develop or modify a release coating for use with ceramic tooling capable of withstanding cure temperatures in excess of 700°F. This release coating must be capable of providing both release and volatile removal for solvent based composite materials which process at temperatures up to 750°F.

DESCRIPTION: The use of castable ceramic tooling for fabrication of solvent-based composite parts requiring two-sided tooling has significant cost advantages if acceptable release materials are available. Solvent based composite materials systems require manufacturing methods which allow in-situ removal of solvents. For parts which require tooling to one surface only, porous materials may be utilized on the non-tooled surface to allow permeation of the volatiles from the part. In the case of parts which require tooling on both surfaces, the tooling material itself must be sufficiently permeable to allow volatile removal and must be finished with an appropriate release coat or be inherently adhesion resistant to the composite material. For tooling materials which are not inherently adhesion resistant, the release coat must not only provide a mechanism for release of the composite part from the tool, but also a mechanism for permeation of the volatiles from the part and through the tooling material.

PHASE I: Develop or modify a release coating material capable of providing both release and volatile removal for solvent based composite materials which process at temperatures up to 750°F. Evaluate the candidate materials' resistance to thermal shock and its adhesion to castable ceramic tools. Additional test will be conducted to evaluate permeability of the release coating material(s).

PHASE II: Build upon the Phase I work to refine the concept, scale-up, and ready the concept for factory floor operations.

DUAL USE COMMERCIALIZATION POTENTIAL: Composite materials have already found widespread application in the commercial market. Improved quality and lower part cost are desired features whether the market

is military or commercial. The concept developed herein will be applicable and beneficial to industries ranging from aerospace to automotive to medical.

REFERENCES: Handbook of Composites, George Lubin, Ed., Van Nostrand Reinhold Company, New York (1982). pp.374, 633-639.

OSD97-018 TITLE: Advanced Fasteners for Low Cost Airframe Assembly and Repair

DOD CRITICAL TECHNOLOGY AREA: Manufacturing Science & Technology

OBJECTIVE: Develop and demonstrate advanced fastener technology that will significantly reduce the cost of airframe assembly. Evaluate the feasibility of using advanced fasteners to relax dimensional tolerance requirements and substantially reduce or eliminate associated tooling cost.

DESCRIPTION: All future DOD weapons systems are being developed with major emphasis on achieving maximum performance at an acceptable cost. The airframe assembly operation represents a major portion of the overall manufacturing cost. Significant potential exists for lowering the cost of assembly by eliminating or reducing the need for drill tooling and pre-assembly fixtures. the development of advanced fasteners that relax hole tolerance requirements could substantially reduce cost associated with the fabrication, certification, and maintenance of high tolerance interchangeable / replaceable drill tooling.

Advanced fasteners are required that allow for loose tolerance holes and provide adequate interface for high load transfer effectively. The new fastener technology should be applicable to both permanent and replaceable fasteners. Tensile strength, shear strength, weight and configuration of the advanced fasteners should satisfy the requirements of advanced fighters such as the F-22 or Joint Strike Fighter (JSF).

PHASE I: Develop advanced fastener concepts for both permanent and replaceable fasteners based on advanced fighter cost and performance requirements. Develop a detail design of an advanced fastener and perform stress and fatigue analysis. Prototype fasteners will be fabricated and screen tested to demonstrate concept feasibility.

PHASE II: Based on Phase I test data, develop detail designs and perform stress and fatigue analysis for the most promising fasteners. Fabricate the advanced fasteners and fastened joint test coupons and test to advanced fighter static and fatigue performance requirements. Perform a life cycle cost analysis for implementation on an advanced fighter.

DUAL USE COMMERCIALIZATION POTENTIAL: This advanced fastener technology could be used to reduce the cost of commercial products such as airliners, business jets, high speed boats, etc. This technology would have wide commercial application and could be used to further reduce the cost of commercial products with mechanically fastened joints.

REFERENCES:
(1) Handbook of Composites, George Lubin, Ed., Van Nostrand Reinhold Company, NY (1982). pp. 602-632. (2) Composite Airframe Structures, Michael C.Y. Niu, Conmilit Press Ltd., Hong Kong (1992).pp. 290-330.

OSD97-019 TITLE: Detection of Hidden Substructure Edges and Holes

DOD CRITICAL TECHNOLOGY AREA: Manufacturing Science & Technology

OBJECTIVE: Reduce assembly cost and time by developing equipment and techniques for locating edges and holes in substructure that are hidden under exterior panels and skins.

DESCRIPTION: The assembly of aircraft structure involves precision alignment of skins to substructure (i.e. bulkheads, frames, spars/ribs, etc.) prior to the drilling and filling of fastener holes. All hole locations and edge distances are constrained to tight tolerances to achieve the lightest structural weight, highest structural integrity, and the lowest radar signature. Closely matched holes that fit snugly to the fasteners at the minimum allowable distanced from the panel's and substructure's edge are desired. The current methods for locating holes and edges requires the assembly technician to use hard templates or to view the assembly from the underside to mark the outer skin with edge and hole location markings. Often excess material and edge distances are required to compensate for alignment inaccuracies. Low cost innovative equipment and techniques are needed that provide the assembly technician with accurate and timely information on the edge and hole locations of hidden substructure relative to mating outer skins. This information should include a visual display or markings to assist the aircraft assembly technician in drilling properly aligned holes and verifying edge distance requirements. Technologies that may apply include compact directional ultrasonics, eddy current measurements, induced thermal or magnetic imagery, laser induced acoustic emissions, etc.

PHASE I: Investigate methods for sensing the location of hidden structures. Evaluate and demonstrate at least one technique that could be used in the assembly shop floor environment.

PHASE II: Develop a system to sense and display the location of hidden structures. Evaluate and demonstrate the system for accuracy and repeatability when used in an aircraft assembly environment.

DUAL USE COMMERCIALIZATION POTENTIAL: The ability to sense and display hidden structure would have a profound impact on both commercial and military markets. Significant cost reductions could be realized in assembly operations; which is the largest single cost area associated with the manufacture of commercial and military aircraft.

OSD97-020 TITLE: Hybrid Composites Manufacturing Technology - Braiding/Filament Winding

OBJECTIVE: Capture the technology developed for braiding / filament winding of organic matrix composites in the Design and Manufacture of Low Cost Composites (DMLCC), Engine program (Contract F33615-91-C-5719) and integrate into a hybrid manufacturing process.

DESCRIPTION: Under the Air Force ManTech program DMLCC, Engine, a hybrid composite manufacturing technology has been developed involving braided and filament wound preform fabrication. The braided/filament wound hybrid composites are proving to be an effective means for fabricating critical, primary load bearing jet engine structures such as a center bypass duct. This is a straight axis part involving both braiding and filament winding with multiple features. Similar work has been done demonstrating the viability of braiding for low cost composite structures in the DMLCC, Wing program as well as in wing and fuselage structures in the NASA ACT program. Currently, the braiding and filament winding processes are done on separate machines, necessitating two machines, removal from one machine to the next, shipment to separate facilities, etc. By combining or hybridizing the two processes into a single machine, significant process improvements and cost savings can be realized.

PHASE I: Provide baseline cost estimates of current practices and define the potential savings to be realized by combining these processes. Design an integrated, multi-axis preform manufacturing system of braiding and filament winding of organic matrix composites that would insure accurate placement of the reinforcing fiber. This hybrid system will allow for the full integration and automation of the preforming processes developed under the DMLCC, Engine and Wing programs.

PHASE II: This effort would focus on the creation and validation of a multi-axis tool handling system to allow for the full integration and automation of braiding and filament winding of preforms.

DUAL USE COMMERCIALIZATION POTENTIAL: The fully integrated multi-axis hybrid preforming system would have application in a myriad of industries. In the aerospace industry, it would be ideal for the production of the center bypass duct that has been the focus of the DMLCC,E program, as well as for the manufacture of non-linear parts such as ducts and fuselage ribs. This technology would also be applicable to a variety of commercial industries such as automotive, medical (prosthetics), sports (hockey sticks, and racket sports) and recreation equipment (bicycle components).